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IN READING**

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THE ROLE OF HABIT IN EYE-MOVEMENTS IN READING*

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The various aspects of the oculo-motor process in reading have concerned many investigators since the pioneer work of Javal. In the beginning the main interest lay in the discovery of the part played by the oculo-motor system in the normal reading process. Subsequent development led through the differentiating factors in various types of reading, the differences between good and poor reading performances as revealed in eye-movements, to the pedagogical problem of improving the reading performance via the eye-movement approach. From these studies there arose the question whether the relative excellence of reading performance as measured by speed and comprehension is determined primarily by the mechanics of oculo-motor coordination, or by less easily observed phenomena variously described as central, the underlying processes of assimilation, etc. The author's own opinion coincides with the latter view. His judgment has been decided by a study of the literature on the subject, and by the results of his own experiments.

Since the issue has interested a multitude of workers, and since there is relatively close agreement between man and man on each side of the argument, a complete review of the literature would be both tedious and unproductive. Only a sampling of the studies, therefore, will be discussed here.

It is at once obvious that, if reading training is to be instituted through eye-movement training, one must discover whether or not eye-movements are amenable to practice. The basis for the belief in the existence of oculo-motor docility is found in the concept of habit in eye-movements. If oculo-motor habits, *qua*, habits in the true sense of learned reactions, can be demonstrated, then presumably the pedagogue or the clinician may expect to institute proper reading movements through training. The earliest and most im-

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portant reference to the concept of motor habits of the eye is found in the work of Dearborn (3).

Using stimulus material of various line lengths and type sizes, Dearborn obtained evidence for what he called "short lived motor habits" of the eyes. These habits are revealed in the consistency of the fixation frequencies from line to line in the same selection. This rhythmical grouping is less often found at the very beginning of a passage, and upon its first reading. But, continues Dearborn, whether this holds true or not seems almost a matter of chance. A case is cited in which the habit appeared suddenly, and full blown, in the second reading of a paragraph, the initial reading of which was characterized by anything but consistency. A second instance demonstrates a "case of motor habit formed from the first line." This is very rapid habit formation indeed.

Dearborn himself is not altogether clear as to the meaning of the term habit as he uses it. Whether it is a motor habit of the eye conditioned by peripheral proprioceptive cues from the ocular musculature, or merely a fortuitous appearance of rhythm conditioned by the consistency of the apperceptive factors of comprehensibility is not made clear. The discussion in general seems to point toward the former conclusion, but evidence for the latter is certainly suggested in the following quotation: "If . . . the difficulties of word recognition, the sequence of words and thought and other such apperceptive conditions remain similar, there would appear to be no reason why the motor habit should not persist." However, Dearborn immediately dismisses this implication with the observation that there is no uniformity in respect to number of fixations per line either between different subjects or the successive readings by the same subject—an observation that led him to characterize these motor habits as "short-lived."

Dearborn resumes his argument by remarking that ease of formation of motor habits characterizes rapid readers. This is not meant to be merely a description of a phenomenon, *i. e.* that the eye movements of fast readers are more regular than those of slow readers. It is meant also to indicate a causal relationship. Fast readers are fast *because* they have more regular eye movements.

But Dearborn is not entirely consistent for later he admits that the determining factors of reading rate may be central and "quite apart from this peculiarity (habit)." And in the same paragraph may be found this passage: "Rapidity of reading is not necessarily correlated with regularity of movement . . ." These assertions contradict those which have gone before, and it is difficult at

times to determine what impression Dearborn wished to convey. In the majority of cases he suggests that the eye is doing the reading and not the individual—that one reads better if one's oculo-motor system is more educable. This, at least, is the interpretation that later writers have put on the concept of "motor habits of the eye."

The concept of "short lived motor habits" and its relation to reading performance met with uncritical acceptance by subsequent investigators.

C. T. Gray (9), in an early monograph on reading, discusses the nature of the motor phases of the reading process. He too pays homage to the motor habit concept. "Dearborn calls attention to another factor which helps to determine the number of pauses. This is the motor habit into which the eye falls as different lengths of line are read." (Italics ours.) The implications are unequivocal. Dearborn is here interpreted to mean that a motor habit of rhythmicity makes it possible for a reader to make fewer fixations, not that the reduction of fixations makes for a reduction in deviations per line, which might show up as habit. The absence of experimental evidence to justify Gray's conclusion suggests that it is made in deference to a popular concept.

Pollack and Pressey (14) turned their attention solely upon eye-movements, and by using a direct method of observation, found that all eye-movement measures differed in favor of good readers. They therefore subscribe to the idea that reading consists largely of certain mechanical habits. Pressey and Truax (25) used experimental and control groups of children in Class IV A and B (i. e. about ten years old). The groups were approximately the same in speed and comprehension. The experimental group was subjected to diagnosis and special training, the greater part of which concerned the training of eye-movements. The mirror observation* method was used to check the number of fixations and regressions, and the accuracy of the return sweep. The training consisted first in the practice of fixating the beginning, middle, and end, of lines of easy material. The children were told about the reading process and were allowed to check each other's progress by observation. The authors, however, do not put much stress on the eye-movement training itself. They admit to a feeling that more important than the practice itself was an understanding which the children gained of the nature of the reading process, etc. The subsequent step, that is, training directed specifically at eye-movements, follows naturally. Pressey (15, 16) devised a manual for the home training of poor readers among

* For reliability of this method see references 17 and 20.

college freshmen. Prominent among the exercises (which include lessons in increasing speed, in paragraph, section and chapter reading, and in interpreting graphs), is a form of "drill in eye-movements." This consists in a few pages of lines, terminated at either end by crosses, and later, bisected by a third cross. Students are instructed to swing their eyes across these lines, stopping only to fixate the crosses, and while so doing, to observe the *feel* of the eye. The sensation referred to supposedly emanates from the "pit of the eye," and, if kept in mind, will afford some measure of the number of fixations made. Having mastered these pages, the student moves on to regular reading material, "continuing these same movements." His eyes are now guided by dots or small crosses "at the approximate places where your eyes should pause." The student is told not to attempt to comprehend the material at first but to keep his "eyes moving correctly," and he is urged to "re-read as often as you need until you get meaning *without disturbing the movements*." The authors report marked improvement in a group of poor readers using this manual. Unfortunately no eye-movement data are given. Nor is there any means of determining to what extent the improvement is due to the eye-movement drill, in comparison to that due to other exercises.

In 1933 Robinson published a monograph entitled "The Role of Eye-Movements in Reading with an Evaluation of Techniques for Their Improvement" (18). The plan of his experiment took the following form: testing a number of individuals on a battery of reading tests, offering training which was calculated to increase the efficiency of eye-movements, and retesting to discover gains in achievement of such existed. The training consisted mainly of "pacing" the eye-movements. The method involved typing the exercise material in spaced phrases. This device ostensibly forced the eyes to make one fixation per group of words. Other techniques for the eye-movement training group "included skimming easy material to find the answer to questions concerning some specific detail." As a further means of improving eye habits the student was urged to push himself in rate, but not at the expense of comprehension. Charts of progress were kept in order to motivate the subject. The final instructions recommended reading as much and as rapidly as possible outside the training period. The inclusion of these latter techniques may seem unwarranted in view of the fact that the author wished to limit training to eye-movement pacing. In the evaluation of results, this point should be kept in mind.

Two control groups were used in this study. In order to determine whether gains are due to mere growth, a second group of poor readers, matched man to man with the experimental group, were given beginning and final testing, but no training. To measure the role of any possible uncontrolled training in comprehension, a third matched group was trained specifically in comprehension with no attention paid to eye-movements. Comprehension training included "organization of ideas," much of the work being done in a non-reading situation. For instance lecture courses were analyzed for main ideas; tables of contents, topical sentences, summary paragraphs, etc., were studied. Outlining and underlining were utilized. Training in vocabulary and even in "the use of maps, tables, charts, and indices" was employed. Finally the students practiced "bringing to mind what they knew of the given topic, in order to evaluate both the material and their concepts for agreements or disagreements."

Robinson's results may be summarized as follows: (1) the no-training group made no reliable gains on any of the measures, (2) the "paced" group exhibited significant gains in rate (including eye-movement measures) and to a lesser degree, improvement in comprehension; (3) the "comprehension" group showed significant gains in comprehension but not in rate. Considering the nature of the training, these results are not surprising. It will be remembered that the student in the "paced group" was told to read rapidly, to skim for main ideas, and "to push himself in his rate, but still to get the idea." This type of training should operate to promote improvement in rate, and even in comprehension without any emphasis being placed on eye-movements. The comprehension group was trained in such factors as might be expected to result in gains in comprehension, but since so much of the work was not in the reading situation, and since it was stressed that "one must read rather to get ideas in the lesson than to cover a certain number of pages," significant increase in rate could hardly be expected.

As Tinker (20) points out in his review of this monograph, Robinson terms all the training given to the "rate" group "eye-movement pacing." He attempts to prove that the gains of the "rate" group were not due to skimming, despite the fact that lessons in skimming were part of the program. He rules out motivation as a possible causal factor, whereas in another place, he avers that "since rate is more objective (than comprehension) it is easier to motivate the student."

Robinson, discussing the nature of eye-movement habits, describes them as "psychophysical dispositions to move the eyes in reading in a more or less constant manner according to certain cues, mostly kinaesthetic, that act independently of the conscious act of understanding the material covered . . ." He alludes to Judd's (12) finding that, within limits, changing the size of type does not affect the number of fixations (Cf also Gilliland, 8) and concludes that these habits of width of fixation consist primarily of "reacting to a given amount of verbal material." It seems to the present writer that this is, as Hollingworth (10) says, a "perception habit" rather than an eye-movement habit. An attempt has been made to show that Robinson's eye-movement training did not exclude possible causal factors such as comprehension, skimming, and motivation. Perhaps elimination of these factors can never be accomplished. It has also been shown that Robinson seems to be discussing perceptual rather than eye-movement habits, and that he has no objective evidence for the existence of oculo-motor habits.

The studies so far reviewed have stressed that eye-movement habits may affect reading efficiency. The opposing group will now be considered.

Whipple (28) wrote on eye-movements in reading and concluded that eye-movements do not condition good or poor reading, but considered them rather as symptomatic of rapidity of assimilation. Schmidt (19), in an extensive study of the reading process, pays tribute to Dearborn by stating that motor habits are important, but vitiates this admission by adding that the role of habit is a small one as compared to the influence of word form and meaning.

Judd's (12) findings, that changing the size of type does not appreciably alter the number of fixations employed, led him to conclude that "the sensory conditions of reading are of less importance than the established habits of recognition," the improvement of which "is probably not in any large degree a matter of training the eyes." In fact Judd is of the opinion that such mechanical training is vicious rather than beneficial since it hinders the pupil temporarily in his attempts to "reach the level of fluent, synthetic grasp of phrases."

Gates (4, 5) reported lack of success in the formal training of eye-movements. In a later book (6) he expresses his doubt as to the efficacy of eye-movements in causing reading deficiencies, and suggests that more plausible determiners may be found in excessive

articulation, etc., which if remedied, would make unnecessary any treatment of eye movements specifically.*

Young (29) found a correlation of .80 (.90 when corrected for attenuation) between the comprehension of visual and auditory material, and since comprehension is the only factor common to these two measures, it alone must be responsible for the magnitude of the correlation. He therefore concludes that "reading seems to be almost wholly a central as opposed to a peripheral activity." Vernon (26, 27) supplied further experimental evidence to justify this conclusion by demonstrating that central states affect the peripheral oculo-motor behavior. In her studies, passages were used which might have interest and emotional values for some readers and not for others. She concluded that the speed and regularity of reading was disorganized by strong conative impulses—i. e., those subjects who showed the greatest interest in the passages were most variable and irregular. Such results imply that eye-movements are symptomatic of the underlying perceptual processes.

From reviews of the literature, Tinker (21, 22, 23) draws three major conclusions: (1) A change in reading attitude or mental set will produce changes in the eye-movement patterns. The studies of Judd and Buswell (13) on reading attitude, and Vernon (26) on mental set are cases in point. (2) When difficult material occurs in an otherwise easy text, (e. g., formulae, foreign phrases, etc.), the difficulties in apprehension are immediately mirrored in the irregularities of the accompanying eye-movements. (3) When foreign languages are read, eye-movements are regular if apprehension of successive words and phrases is orderly, but when apprehension becomes difficult, eye-movements become irregular, approximating confused wandering where there is little or no comprehension (Cf. Judd and Buswell (13) and Buswell (1)). The burden of these themes is, according to Tinker, essentially the same: central processes of perception and apprehension condition eye-movement processes. Writing with Frandsen (24), he observed that oculo-motor processes are exceedingly flexible and quickly reflect slight changes in the nature of the underlying concurrent cognitive-perceptual processes. In certain situations, an increase in the number and irregularity of fixations may actually be indicative of an improved reading ability.

* In a recent revision of this book, Gates (7) has changed his position considerably. Emphasizing the importance of orderly sequences of perception in reading, he stresses the need of developing eye-movements from left to right along the line. While the former is undoubtedly required for efficient reading (i. e. orderly perceptual sequences), it does not follow from that that eye-movements should be trained.

In a recent investigation into oculo-motor patterns employed in looking at pictures, Buswell (2) makes it quite clear that eye-movements should be considered as symptomatic of perceptual processes, that they are entirely unconscious and therefore not amenable to introspective analysis. In brief his position is that "Eye-movements are unconscious adjustments to the demands of attention during a visual experience."

Such are the two sides of the argument (the supply of opinions on the subject have by no means been exhausted). It is strange, since the issue is well defined and vigorously contested, that there has been no attempt to measure the amount of "habit" before and after reading training. In a study by the author (to be reported in another place), a measure of line-to-line consistency (Habit Index) was derived from the eye-movement records of sixty subjects reading a variety of paragraphs in six different line lengths. It was found that the measure of consistency (Habit Index) was higher for short than for long lines, as Dearborn had claimed. Moreover, good readers showed higher Habit Indices than poor readers. Further analysis, however, revealed that these relationships were not to be interpreted to favor the habit concept. On the contrary, high line-to-line consistency is obviously a necessary result of the fact that short lines are usually read with fewer fixations than long lines, and that good readers are defined as those who read with fewer fixations per line. It seems sensible to assume that an individual who reads each line of a paragraph rapidly—*i. e.*, with a minimum number of fixations, will necessarily have a high line-to-line consistency. A person, for example, who reads each line of a selection with four fixations will have a perfect Habit Index. Likewise, a reader who makes fourteen fixations on each line of the same paragraph will have a perfect Habit Index, but will not be, by relative standards, a good reader. A poor reader may sometimes read in this manner, as Dearborn was well aware, but he usually finds some lines easier than others, or skims some, or dawds on some, or a number of other things. He therefore usually has a low Habit Index.

Another point revealed by our study, and one which strengthens the above conclusion, is that Habit Index is not a stable trait. It was found that no prediction could be made regarding an individual's Habit Index on a given paragraph from a knowledge of his Habit Index on another paragraph. In fact, in some cases, those who had indices higher than average on one paragraph, were lower than average on another, and one of these differences was very near statistical reliability.

Finally, the habit concept seems to assume a concept of "equal span" which we believe is untenable. In other words, the proponents of habit, and especially those who give eye-movement training with a view to setting up habits of eye-movement, seem to assume that these "regular, rhythmical fixations" are equi-spaced across the line. This is, of course, far from the true state of affairs. The usual picture of plotted fixations reveals, even for good readers, many instances of more than one fixation per word. What can be common to the reading performance of two lines, each with four fixations, if in one case these are equi-spaced and in the other they fall on only two words in the line?

The only conclusion that can be drawn from a review of the literature, and from our own results, is that eye-movements (including regularity) are not in any way explanations of reading ability, but are expressions or symptoms of underlying processes of assimilation.

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